AMCC CASTING DEVELOPMENT
FINAL REPORT

NASA Contract No. NAS8-39027

Data Requirement #DR-06

Volume I - Executive Summary

Nasa Dwg. #96M66441 / PCC P/N 20013

March 28th, 1995

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Data Requirement Overview (NASA contract no. NAS8-39027):

DR-01 Technical Implemention Plan: See pages 1 thru 11 & 24 thru 39 of 'Technical Proposal - NASA AMCC Volume 1', dated 9/12/91, which is included with Volume II - Final Report.

DR-02 Logic Network and Key Milestone Charts: See pages 19, 20, 22 & 23 of 'Technical Proposal - NASA AMCC Volume 1', dated 9/12/91, and updates included in the Preliminary Design Reviews dated 8/26/92 & 10/12/93 (included with Volume II - Final Report).

DR-03 Casting Hardware Acceptance Test and Inspection Plan: See pages 12 thru 18 & 21 of 'Technical Proposal - NASA AMCC Volume 1', dated 9/12/91, and updates included in the Preliminary Design Reviews dated 8/26/92, 10/12/93 & 9/21/94 (included with Volume II - Final Report).

DR-04 Detailed Design Review: See the 'Preliminary Design Review', dated 9/21/94, which is included with Volume II - Final Report.

DR-05 Final Review: Deleted due to Program Cancellation.

DR-06 Final Report: See the table of contents on page 3 & see Volume II - Final Report.

DR-07 Casting Specification: See the table of contents on page 3 of Volume II - Final Report.

DR-08 Quarterly Reports: See the table of contents on page 3 of Volume II - Final Report.

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Significant Achievements & Activities:

PCC successfully cast and performed non-destructive testing , FPI & X-ray, on seventeen AMCC castings (NASA dwg. #96M66441 / PCC P/N 20013). Destructive testing, lab analysis & chemical milling, was performed on eleven of the castings and the remaining six castings were shipped to NASA or Aerojet. Two of the six castings shipped , lots 015 and 016, were fully processed per blueprint requirements. PCC has fully developed the gating and processing parameters of this part and feels the part could be implemented into production, after four more castings have been completed to ensure the repeatability of the process.

The AMCC casting has been a technically challenging part due to its size, configuration and alloy type. The height and weight of the wax pattern assembly neccessitated the development of a hollow gating system to ensure structural integrity of the shell throughout the investment process. The complexity in the jacket area of the casting required the development of an innovative casting technology that PCC has termed 'TGC' or Thermal Gradient Control. This method, of setting up thermal gradients in the casting during solidification, represents a significant process improvement for PCC and has been successfully implemented on other programs. The alloy, JBK-75, is a relatively new alloy in the investment casting arena and required our engineering staff to learn the gating, processing and dimensional characteristics of the material.

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Results:

Metallurgical integrity of the final four castings was very good. Only the areas of the parts that utilized 'TGC Shape & Location System #2' (see 'Preliminary Design Review' dated 9/21/94 - included in Volume II - Final Report) showed any significant areas of microshrinkage when evaluated by Non-Destructive Tests (FPI & X-ray). Alumina Oxides detected by FPI on the 'float' surfaces (top side surfaces of the casting during solidification) of the part were almost entirely less than the acceptance criteria of .032" in diameter. Destructive chem mill of the castings was required to determine the effect of the process variables used during the processing of these last four parts (with the exception of the 'Shape & Location of TGC' variable). The worst area of microshrinkage, detected by lab analysis of non-chem milled sections of the final four castings, was 4.5% shinkage in a heavy cross-sectional area of the part (see lab results in 'Preliminary Design Review' dated 9/21/94 - included with Volume II - Final Report). Maximum observed IGA/IGO, in these same four parts, was .001" and only localized pooling of eta phase was detected in the heavy cross-sectional areas (see lab results in 'Preliminary Design Review' dated 9/21/94 - included with Volume II - Final Report). Maximum columnar grain detected is 1.3" and the maximum equiaxed grain detected is 0.9" (see lab results in 'Preliminary Design Review' dated 9/21/94 - included with Volume II - Final Report).

Dimensional conformance of the final four castings was very good. The only significant dimensional characteristics with a Cpk less than '1.0' are the jacket profile from datums and the mis-match requirement of the manifold patches (see dimensional review in 'Preliminary Design Review' dated 9/21/94 - included with Volume II - Final Report).

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Conclusions:

The gating & processing parameters, when utilizing TGC 'Shape & Location system #1' (see Preliminary Design Review dated 9/21/94 - included with Volume II - Final Report), appears to be ready for production, but will require the processing of an additional four castings to ensure the repeatability of the process.

The dimensional conformance of the part appears to be ready for production with the exceptions of the jacket profile from datums & the mis-match requirement of the manifold patches (see Design Recommendations on pg. 7 & see dimensional review in 'Preliminary Design Review' dated 9/21/94 - included with Volume II - Final Report).

3/28/95

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Design Recommendations:

PCC has determined that the AMCC casting (NASA dwg. #96M66441 / PCC P/N 20013) is fully castable in its current form. PCC strongly recommends that all castings produced from JBK-75 be designed, as this part was, with an FPI non-interpretable level of .032" in diameter. PCC recommends construction of a one piece tool, to form the jacket area of the casting, to enable PCC to meet the jacket profile from datums criteria. The other alternative to this would be relaxation of the criteria on the blueprint. The mis-match requirement for the manifold patches as currently called out on the drawing is not within the process capability of this casting. PCC recommends that NASA & PCC concurrently engineer a resolution to this dimensional non-conformance.

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Pam Wright / Dimensional Engr.

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